

OTP Creation Guide

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ABSTRACT

This document provides instructions for creating the 512-byte OTP contents of the TCA8424. Project collateral discussed in this application report can be downloaded from the following URL: <http://www.ti.com/lit/zip/SCDA013>.

Contents

1	Memory Overview	2
2	Memory Contents	2
2.1	I2C Address	2
2.2	HID Descriptor	3
2.3	Report Descriptor	4
2.4	Keyboard Map	4
2.5	Auxiliary Keyboard Map	5
2.6	Function Key Location	6
2.7	Report IDs	6
2.8	Report ID1 and Report ID2 Usage IDs	7
2.9	Auxiliary Register	7

Figures

Figure 1.	Example Keyboard Map	5
Figure 2.	Auxiliary Keyboard Map	6

Tables

Table 1.	Memory Organization	2
Table 2.	HID Descriptor	3
Table 3.	OTP Inputs	5
Table 4.	Report ID Bit Numbers	7

1 Memory Overview

Table 1 indicates how the memory is organized.

Table 1. Memory Organization

Location		Contents	Comments
	0x000	I2C Address	Most significant 7 bits are the I2C address. Last bit must be a 1.
Start End	0x001 0x01E	HID Descriptor	30 bytes
Start End	0x01F 0x0DF	Report Descriptor	Up to 193 Bytes
Start End	0x0E1 0x160	Keyboard Map	128 Bytes
Start End	0x161 0x1E0	Auxiliary Keyboard Map	128 Bytes
	0x1E1	Function Key intersection	Format is column/row
	0x1E2	Default Report ID	Cannot be 0
	0x1E3	Report ID1	Cannot be 0
	0x1E4	Report ID2	Cannot be 0
	0x1E5	Report ID3	Cannot be 0
	0x1E6	Report ID4	Cannot be 0
Start End	0x1E7 0x1EE	Report ID1 Usage IDs	
Start End	0x1EF 0x1F6	Report ID2 Usage IDs	
Start End	0x1F7 0x1FA	Report ID3 Usage IDs	
Start End	0x1FB 0x1FE	Report ID4 Usage IDs	
	0x1FF	Auxiliary Register	Must be 0x00

2 Memory Contents

2.1 I2C Address

- The I2C address is located at 0x000 in the OTP contents.
- The I2C address must be in the following format:
 - The Most significant 7 bits are the 7-bit slave address and the R/W bit must be set to 1 in the OTP contents
 - That is, an I2C address of 0x76(W) or 0x77(R) would be represented in bitfield as:
0111 011(1) ← R/W bit must be 1 in OTP contents

2.2 HID Descriptor

The HID descriptor contains the information shown in [Table 2](#) at each respective byte location. Items in red can vary while items in black must always be the indicated value.

Table 2. HID Descriptor

OTP Address	Contents	Description
0x001	1E	HID Descriptor length (LSB first)
0x002	00	
0x003	00	BCD version
0x004	01	
0x005	XX - Varies	Report Descriptor Length
0x006	00	
0x007	30	Report Descriptor Address
0x008	00	
0x009	00	Input Register Address
0x00A	40	
0x00B	0B	Max Input Report Length
0x00C	00	
0x00D	00	Output Register Address
0x00E	05	
0x00F	03	Max Output Report Length
0x010	00	
0x011	00	Command Register Address
0x012	06	
0x013	00	Data Register Address
0x014	07	
0x015	47	Vendor ID
0x016	20	
0x017	01	Product ID
0x018	04	
0x019	00	Version ID
0x01A	01	
0x01B	00	RESERVED
0x01C	00	
0x01D	00	
0x01E	00	

The Report Descriptor length is the number of bytes used for the report descriptor and will vary with application. The maximum report descriptor length is 193 bytes.

Note: An incorrect Report Descriptor Length creates enumeration errors with the host.

2.3 Report Descriptor

The report descriptor field varies from keyboard to keyboard, mainly based on the auxiliary keyboard map and the special function keys that are being used.

- The HID information page is found [here](#).
- The HID Descriptor creation tool is found [here](#).

2.4 Keyboard Map

The keyboard map contains the [HID Usage Table 1.12](#) codes for each key on the keyboard at the appropriate row/column intersection.

- Usage IDs should only be populated for keys that exist
- Any unused row column intersection must be left 0x00
- The function key row/column intersection should be both:
 - Non-zero
 - A non-valid usage ID.
 - Example of appropriate value at Function key intersection is 0xFE

[Figure 1](#) shows a row column map of the usage IDs associated with an example keyboard matrix.

Notice the following:

- FN key has an usage code of 0xFE
- All location with 0x00 have no key

```

00, 00, 1A, 16, 04, 1D, 00, KEY_FN(FE), // (Row0,col0), ..., (Row0,Col17)
00, 00, 00, 00, 00, 00, 00, E3,
00, 00, 00, 00, 00, 00, E6, E2,
22, 21, 15, 08, 09, 07, 1B, 00,
24, 23, 17, 0B, 0A, 19, 06, 2C,
26, 25, 18, 1C, 0D, 11, 05, 31,
2D, 27, 12, 0C, 0F, 0E, 36, 10,
00, 2E, 30, 28, 00, 00, 00, 65,
00, 00, 00, 00, E5, E1, 00, 00,
00, 00, 00, 00, 00, E4, 00, E0,
00, 00, 00, 00, 00, 00, 00, 00,
2F, 13, 34, 33, 38, 37, 00, 00,
43, 42, 2A, 20, 1F, 52, 46, 48,
49, 4C 00, 4B, 4E, 4F, 51, 50,
44, 45, 41, 14, 3D, 3C, 1E, 40,
29, 35, 3E, 2B, 3A, 3B, 39, 3F, // Row 15.

```

Figure 1. Example Keyboard Map

The map in [Figure 1](#) must be input into the OTP as shown in [Table 3](#):

Table 3. OTP Inputs

Address	Contents (Based on Figure 1)	Description
0x0E1	00	Column 0 Row 0
0x0E2	00	Column 0 Row 1
0x0E3	00	Column 0 Row 2
0x0E4	22	Column 0 Row 3
0x0E5	24	Column 0 Row 4
...
0x160	3F	Column 0 Row 15

As seen above, you must enter the first full column, then the second, then the third, and so forth, until all columns have been entered.

2.5 Auxiliary Keyboard Map

The Auxiliary keyboard can be formatted slightly different but must follow these rules:

- All row/column intersections that don't make use of the function key must be 0x00
- Any regular keyboard key should use the default Usage ID
- If special function keys are used such as consumer controls (that is, volume up and down) then the key code entered in the Auxiliary keyboard map must match that entered into the respective report ID.
- The function key location should read 0x00

Aside from these rules, the method of inputting the keyboard map into the OTP remains the same as the Regular Keyboard Map described above. The alternate keyboard map for the example keyboard is shown in [Figure 2](#).

```
// Fn - Keys
00, 00, 00, 00, 00, 00, 00, 00, // (Row0,col0), ..., (Row0,Col7)
00, 00, 00, 00, 00, 00, 00, 00,
00, 00, 00, 00, 00, 00, 00, 00,
00, 00, 00, 00, 00, 00, 00, 00,
24, 00, 00, 00, 00, 00, 00, 00,
26, 25, 21, 00, 1E, 00, 00, 00,
00, 38, 23, 22, 20, 1F, 00, 27,
00, 00, 00, 00, 00, 00, 00, 00,
00, 00, 00, 00, 00, 00, 00, 00,
00, 00, 00, 00, 00, 00, 00, 00,
00, 00, 00, 00, 00, 00, 00, 00,
00, 55, 00, 56, 57, 37, 00, 00,
00, 00, 00, 00, 00, E9, 00, 00,
00, 00, 00, 4A, 4D, 6F, EA, 70,
83, 47, E2, 32, 00, 00, 00, 00,
EE, 00, 62, 00, 75, 00, 00, 00, // Row 15.
```

Figure 2. Auxiliary Keyboard Map

2.6 Function Key Location

The function key location indicates the row/column intersection of the FN key. For the example keyboard map shown in [Figure 1](#), the row/column intersection is:

- row 0 column 7

The OTP contents for the Function Key Location must be formatted as follows:

- Most significant nibble is the column number
- Least significant nibble is the row number

If we follow this format for our example, we would input 0x70 into the OTP contents at address 0x1E1.

2.7 Report IDs

The report IDs are the IDs sent to the host during an input report. The report ID tells the host what is contained in the input report and must follow these rules:

- Report IDs must be nonzero
- Report IDs must match Report IDs used in the Report Descriptor.

2.8 Report ID1 and Report ID2 Usage IDs

Report IDs 1 and 2 can represent 8 different keys using bitfield representation.

The 8 bytes must follow these rules:

- Usage Codes can be any value as long as it matches the key in the Auxiliary keyboard map
- Usage Codes must be the same order as described in the report descriptor
 - that is, bit0 in the report descriptor corresponds to bit0 of the Usage IDs

For more information in Special Modifier keys and alternate report IDs, please see the datasheet.

Table 4 indicates the bit number for each of the report IDs.

Table 4. Report ID Bit Numbers

Address	BIT Number	Description
0x1E7	bit0	Report ID1 Usage Codes
0x1E8	bit1	
0x1E9	bit2	
0x1EA	bit3	
0x1EB	bit4	
0x1EC	bit5	
0x1ED	bit6	
0x1EE	bit7	
0x1EF	bit0	Report ID2 Usage Codes
0x1F0	bit1	
0x1F1	bit2	
0x1F2	bit3	
0x1F3	bit4	
0x1F4	bit5	
0x1F5	bit6	
0x1F6	bit7	
0x1F7	bit0	Report ID3 Usage Codes
0x1F8	bit1	
0x1F9	bit2	
0x1FA	bit3	
0x1FB	bit0	Report ID4 Usage Codes
0x1FC	bit1	
0x1FD	bit2	
0x1FE	bit3	

2.9 Auxiliary Register

The Auxiliary register should always be 0x00 in the OTP contents.

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